

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey
of
The Paradise-Verde Area
Arizona

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SOIL SURVEY

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By F. O. YOUNGS, in Charge, T. W. GLASSEY, and E. N. POULSON, U. S. Department of Agriculture, and M. R. ISAACSON, University of Arizona

AREA SURVEYED

The Paradise-Verde area is in the south-central part of Arizona, in Maricopa County, about 6 miles north of Phoenix at the nearest point. (Fig. 1.) It lies north of and adjoins the Salt River Valley area¹ and is separated from the Buckeye-Beardsley area² by New River on the west, from which boundary it extends southeast to the Salt River Indian Reservation. The Arizona Canal forms the southwest boundary and the abandoned Old Verde Canal most of the northeast boundary. The area includes the proposed irrigation project of the Verde River Irrigation and Power District and comprises 209 square miles, or 133,760 acres.

The physiography of this area is characterized by scattered groups of low rocky barren mountains or hills and large fairly level valleys. Alluvial fans slope rather steeply for a short distance from the base of the hills, but gradually merge into gently sloping valley floors. Across the valleys flow intermittent rivers, creeks, and washes, depositing sediments, cutting, and filling, thereby producing a relief which is characterized by parallel alternating flats and low ridges.

Extending across the area from southeast to northwest is a chain of rocky hills including Camelsback Mountain, Phoenix Mountains, Lookout Mountain, and Union Hills. This chain is broken by a 1½-mile gap north of Lookout Mountain. East and northeast of these hills lies Paradise Valley; west of them lies Deer Valley, with two minor arms, Little Deer Valley and Moon Valley. Northeast of Paradise Valley, outside the area surveyed, are the McDowell Mountains, whose steep fan slopes extend into the area. Northwest of Deer Valley are the Hedgpeth Hills, Deem Hills, and Luden Mountain. A number of isolated volcanic buttes occur in Deer Valley, the largest two being Adobe Mountain and Moon Hill.

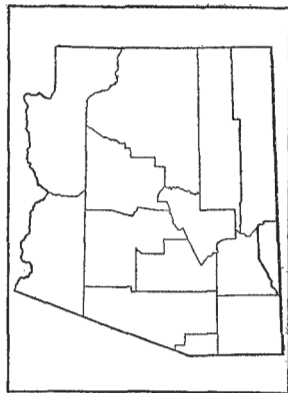


FIGURE 1.—Sketch map showing location of the Paradise-Verde area, Arizona

¹ HARPER, W. G., STRAHORN, A. T., YOUNGS, F. O., ARMSTRONG, S. W., and SCHWALLER, H. C. SOIL SURVEY OF THE SALT RIVER VALLEY AREA, ARIZONA. U. S. Dept. Agr., Bur. Chem. and Soils Ser. 1926, Rpt. 32, p. 55, illus. 1931.

² HARPER, W. G., and YOUNGS, F. O. SOIL SURVEY OF THE BUCKEYE-BEARDSLEY AREA, ARIZONA. U. S. Dept. Agr., Bur. Chem. and Soils Ser. 1927, pt. 3, 43 p., illus. 1930.

The elevation in the area ranges from 1,175 feet to 2,700 feet above sea level. The lowest point is at the confluence of Skunk Creek and New River. At the eastern end of the area, where the Verde Canal will enter, the elevation is about 1,575 feet. The highest points are Camelsback Mountain and Squaw Peak in the Phoenix Mountains. McDowell Peak, northeast of the area, attains an elevation of 4,022 feet.

Drainage is exceptionally good. There are no poorly drained spots, and harmful alkali accumulations have not been found, though traces are present in the subsoil in places. A notable feature of the drainage is the large number of roughly parallel drainage channels. The land has a good slope, and numerous desert washes give good surface drainage generally, although at times the narrow flats along the intermittent streams are overflowed. New River, Skunk Creek, and Cave Creek drain Deer Valley, and Paradise Valley is drained partly by Cave Creek and partly by Paradise Wash which is south of the area.

The Paradise-Verde area is desert country and is very sparsely settled. A number of health camps and sanitariums are located near the Phoenix Mountains, the chief health centers being at Sunny Slope and Cactus. Some tuberculosis patients and health seekers have their homes on the desert, and a number of families live on isolated ranches. Most of the inhabitants are American-born whites. During the winter and spring transient Mexican shepherds and cattlemen graze livestock in the area.

There is no railroad within the area, but Phoenix, which is only a few miles to the south, is served by the Southern Pacific Railroad and the Atchison, Topeka & Santa Fe Railway. The last-named line also passes through Glendale and Peoria a few miles south of Deer Valley. Good, improved roads, many of them paved, lead up to the south edge of the area, but in the desert area itself good roads are comparatively few. The Black Canyon Highway, which is graded and graveled and is the main road between Phoenix and Prescott, crosses Deer Valley. Other good graded roads lead north from Scottsdale to the north boundary of the area, east and west through Paradise Valley, from the east boundary to Phoenix Mountains, and east and west through Deer Valley, connecting with the Black Canyon Highway between Ts. 2 and 3 N. Several miles of road in other localities have been graded.

CLIMATE

The climate of this area, like that of other lower-lying areas of south-central and southwestern Arizona, is hot and arid, with a high proportion of sunny days. The summers are long and hot; the winters short and mild. The highest temperature on record at the Phoenix station is 117° F., the lowest 16°, and the mean annual temperature 69.7°. The daily temperature range is great, the nights generally being comparatively cool even in hot weather. The average frost-free season is from February 12 to December 4, a period of 294 days. The latest recorded killing frost occurred on March 31 and the earliest, November 5. The higher slopes are comparatively frost free, and this is of special significance in the growing of citrus fruits.

The annual average precipitation is low (7.9 inches) and of little benefit to agriculture. At the Phoenix station it has varied from 3.03 inches to 19.73 inches. It occurs largely at two different periods, the greatest amount falling in the summer from July to September, inclusive, and a considerable proportion falling during the winter, from December to February, inclusive. The late spring and fall seasons are generally almost rainless. The amount of rainfall appears to be slightly greater in the higher parts of Paradise Valley than at Phoenix and in the lower parts of the area, as evidenced by the greater moisture content in the soil, greater degree of moisture penetration, and more luxuriant growth of annual herbs in the higher locations than in the lower places at the time of the survey.

In Table 1 are given the normal monthly, seasonal, and annual temperature and precipitation as recorded at the United States Weather Bureau station at Phoenix. These data are representative of climatic conditions in the Paradise-Verde area.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Phoenix, Maricopa County, Ariz.

[Elevation, 1,108 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1924)	Total amount for the wettest year (1905)
December.....	°F. 52.0	°F. 80	°F. 22	Inches 0.59	Inches 1.16	Inches 0.58
January.....	51.2	81	16	1.17	.00	3.31
February.....	55.2		24	.72	(¹)	4.64
Winter.....	52.8	92	16	2.48	1.16	8.53
March.....	60.7	95	36	.49	.99	2.38
April.....	67.0	102	37	.43	.22	2.59
May.....	75.0	114	39	.03	.01	.04
Spring.....	67.6	114	30	.95	1.22	5.01
June.....	84.5	116	49	.12	(¹)	.15
July.....	89.8	117	68	1.07	.09	.28
August.....	88.5	113	55	.96	.14	.92
Summer.....	87.6	117	49	2.15	.23	1.35
September.....	82.7	112	47	1.01	.12	1.23
October.....	70.6	105	36	.35	.30	.00
November.....	59.7	92	28	.96	(¹)	3.61
Fall.....	71.0	112	28	2.32	.42	4.84
Year.....	69.7	117	16	7.90	3.03	19.73

¹ Trace.

SOIL SERIES AND TYPES

In the Paradise-Verde area, 5 soil series, including 14 soil types, and 11 phases were mapped; also 2 classes of miscellaneous materials.

A soil series is a group of soils which have certain dominant characteristics in common, such as color, physical and chemical character of soil and subsoil, and drainage, but which differ from each other in texture of the surface soil. In this area the soil series were differentiated largely on the basis of degree of leaching of the surface

soil, and of compaction and accumulation of clay, colloids, and lime in the subsoil; color was also a factor. A soil type represents a textural division within a soil series based on the relative proportion of the various-sized soil particles, whether stony sandy loam, gravelly sandy loam, sandy loam, fine sandy loam, loam, or silt loam. Soils of heavy texture have high percentages of the fine soil particles such as clay and silt, whereas the lighter-textured soils contain more coarse particles, such as sand, gravel, and stone. A phase is a subordinate division within a type, based on some minor variation, such as difference in depth of soil material or slight difference in texture.

On the soil map each soil type and each kind of miscellaneous material is shown by a different color and a letter symbol. The phases are shown by crosslines or symbols on the type color.

The soils of the Mohave series have light reddish-brown or pale-red friable surface soils over compact heavy dull-red subsurface soils and mottled light-gray and pinkish-brown compact limy subsoils.

The Laveen soils are characterized by light brownish-gray, flesh-colored, or light pinkish-brown mellow surface soils overlying compact gray or pinkish-gray subsoils which consist of a soft nodular lime-carbonate hardpan or caliche.

The Pinal soils consist of a thin surface layer of light grayish-brown or pronounced reddish-brown soil resting on solidly cemented lime-carbonate hardpan or caliche.

The soils of the Anthony series have pale-red, light-gray, or pinkish-brown friable surface soils, slightly or distinctly calcareous, overlying light-gray or pinkish-brown calcareous subsoils somewhat compact and cloddy and faintly veined with lime. Irregular, loose, sandy layers occur in some places in the subsoils.

The surface soils of the Cajon soils consist typically of deep friable alluvial deposits having a light grayish-brown or light-brown color. In many places the subsoils are stratified but are free from compact layers. Lime is distributed evenly in both surface soil and subsoil.

In the following pages of this report the soils of the Paradise-Verde area are described in detail, and their agricultural importance is discussed. The accompanying map shows their distribution, and Table 2 gives their acreage and proportionate extent.

TABLE 2.—Acreage and proportionate extent of the soils mapped in the Paradise-Verde area, Arizona

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Mohave loam.....	20,864	19.1	Anthony fine sandy loam.....	2,688	2.0
Heavy phase.....	576		Pinal fine sandy loam.....	2,496	1.9
Stony phase.....	1,472		Pinal stony sandy loam.....	12,864	10.2
Gravelly phase.....	2,624		Gravelly phase.....	768	
Mohave sandy loam.....	9,024	17.0	Cajon fine sandy loam.....	4,480	3.4
Gravelly phase.....	7,232		Cajon silt loam.....	2,432	1.8
Stony phase.....	6,592		Cajon sandy loam.....	2,496	2.4
Mohave fine gravelly sandy loam.....	3,584	7.1	Light-textured phase.....	704	
Deep phase.....	5,888		Laveen fine sandy loam.....	3,392	2.5
Mohave fine sandy loam.....	5,824	4.4	Laveen gravelly sandy loam.....	3,328	2.5
Anthony sandy loam.....	8,704	8.7	River wash.....	2,304	1.7
Stony phase.....	3,008		Rough stony land.....	17,408	13.0
Anthony loam.....	2,688	2.3	Total.....	133,760	
Light-textured phase.....	256				
Heavy-textured phase.....	64				

MOHAVE LOAM

The surface soil of Mohave loam to a depth ranging from 6 to 10 inches is light reddish-brown friable or slightly compact gritty loam, generally not calcareous. The topmost 2 or 3 inches have a crustlike structure and are somewhat duller or grayer than the soil just beneath. The subsurface soil, or upper subsoil layer, which extends to a depth ranging from 18 to 36 inches, is dull-red compact cloddy heavy loam or clay loam, generally not calcareous though in some places seamed and veined with gray lime-carbonate accumulations. The lower subsoil layer is mottled light pinkish-gray and reddish-brown highly calcareous compact heavy loam or clay loam. In most places the lime concentration and compaction extend to a depth of 6 or more feet.

Mohave loam is the most extensive soil in the area, its total extent, including 3 phases, being 39.9 square miles. It occupies comparatively long narrow flats scattered throughout the area. Drainage is fairly good. Owing to the comparative flatness of the land and the drainage from slightly higher-lying lands, moisture penetrates to a greater depth in this than in many other soils of the area. No accumulation of alkali salts was found.

None of this soil is under cultivation at present. It is very similar to Mohave loam in the adjoining Salt River Valley area where it is the most extensive soil mapped and is considered well suited to most of the common crops of the region, such as alfalfa, cotton (long and short staple), wheat, barley, grain sorghums, truck crops, and citrus and other subtropical fruits. With irrigation, conditions appear favorable for the production of all these crops on this soil in the Paradise-Verde area. However, some of the land is too low and flat to be good citrus-fruit land, but in the higher situations, having good air drainage and consequent freedom from frost, it appears to be well suited to the culture of grapefruit, oranges, and other tender fruits and vegetables.

The native vegetation consists largely of bur sage, or rabbit bush, with scattered creosote bush, mesquite, paloverde, and ironwood. Clearing will not be very difficult or expensive, and comparatively little leveling will be necessary for irrigation.

Mohave loam, heavy phase.—The heavy phase of Mohave loam is inextensive, there being less than 1 square mile mapped. One small tract is in Paradise Valley and four in Deer Valley. In three of the bodies in Deer Valley the surface soils are recent deposits laid down behind the banks of the Arizona Canal.

This soil joins with Mohave clay loam and McClellan clay loam of the Salt River Valley area, but was not sufficiently extensive to be recognized as a separate type in the present survey.

This soil is practically identical with Mohave loam except that the surface soil is heavier, being heavy loam, clay loam, silty clay loam, or, rarely, clay. The subsoil also tends to be heavier than typical.

This soil is still in its virgin condition. It is similar to Mohave clay loam and McClellan clay loam, mapped in the Salt River Valley area, which produce crops similar to those grown on Mohave loam. It is perhaps not well suited to the growing of citrus fruits,

as it occurs on low ground subject to frost. It is probably better suited to lettuce culture than are the lighter-textured soils.

Mohave loam, stony phase.—The stony phase is very similar to typical Mohave loam, the principal differences being a scattering of small bowlders, cobbles, and gravel on the surface and, in some places, in the surface soil and subsoil. In most places the surface soil is slightly redder than typical Mohave loam. This stony soil occurs in Deer Valley in the vicinity of Adobe Mountain, where it occupies comparatively flat or gently sloping areas, generally very slightly higher than those occupied by typical Mohave loam. None of the land is under cultivation. The stone and gravel in the surface soil will necessitate clearing in preparing the land for cultivation, after which the soil will probably have much the same value and crop adaptations as typical Mohave loam.

The native vegetation consists largely of creosote bush and bur sage, with scattered paloverde, ironwood, and mesquite.

Mohave loam, gravelly phase.—Mohave loam, gravelly phase, occurs in Deer Valley. It is similar to typical Mohave loam, but is a trifle grittier in texture and has a scattering of gravel concentrated largely on the surface. Like the stony phase, it lies very slightly higher and is not quite so flat as typical Mohave loam. The surface soil is distinctly calcareous in places. None of this gravelly soil is under cultivation.

MOHAVE SANDY LOAM

Mohave sandy loam is of considerable extent and potential agricultural importance. Its principal development is in Deer Valley, and it occurs to less extent in Little Deer Valley and in the northwest and southwest parts of Paradise Valley. It occupies alluvial fans having moderate slope and smooth or slightly ridged surface affording good drainage.

The surface soil is light reddish-brown or pale-red slightly or distinctly calcareous friable sandy loam containing a considerable amount of coarse grit and here and there a small quantity of gravel. The subsurface soil, or upper subsoil layer, which occurs at a depth ranging from 10 to 18 inches, is dull-red or reddish-brown gritty heavy loam or clay loam somewhat seamed or netted with light-gray lime carbonate. It has a compact and cloddy structure. At a depth ranging from 18 to 30 inches is a mottled light-gray and light reddish-brown compact and cloddy layer of high lime concentration, which in most places extends to a depth of 6 or more feet, though in places the lime content decreases somewhat below a depth of 3 or 4 feet. The texture is variable but generally slightly heavier than in the surface soil.

This soil is not under cultivation at present. It will probably prove well suited to alfalfa and cotton and may be used also for small grains and grain sorghums, though it is rather light in texture for best yields of these crops. Grapes, dates, and other subtropical fruits will probably do well on this soil, and in the higher places having good air drainage and comparative freedom from frost the growing of citrus fruits may prove profitable.

The native vegetation consists largely of creosote bush, with some bur sage, scattered paloverde, and giant and cholla cacti. Clearing

is generally easily accomplished, and a little leveling will be necessary in some of the more ridgy areas before the land can be properly irrigated.

Mohave sandy loam, gravelly phase.—This gravelly soil occurs on old alluvial fans scattered throughout the western half of the area, largely in rather long narrow ridges only a few feet high extending across Deer Valley. The higher-lying bodies near the hills have a fairly steep slope and are rather badly gullied by the desert washes. The total extent of the phase is 11.3 square miles.

The gravelly phase of Mohave sandy loam has a rather heavy surface concentration of gravel locally known as a "desert pavement." The gravel and stones are stained or have a very thin coating of dark-brown or black, highly burnished "desert varnish." The top-most 2 or 3 inches of fine soil material generally form a dull-brown or light pinkish-brown soft crustlike layer. Underlying this is friable pale reddish-brown gravelly sandy loam extending to an average depth of about 1 foot. These upper layers may or may not be distinctly calcareous. They are underlain by compact gritty loam or clay loam, veined with lime accumulations. At a depth of 18 or more inches is a compact highly calcareous and, in some places, nodular mottled light pinkish-gray and pale pinkish-brown gravelly loam or gravelly sandy loam which in many places extends to a depth of 6 or more feet, but generally is underlain at a depth of 3 or more feet by a looser gravelly substratum. This soil phase merges into adjoining areas of Pinal stony sandy loam. In some of the narrow strips in the lower part of Deer Valley the amount of gravel is less than in most areas, being more or less scattered and confined largely to the surface.

This soil will probably not prove so well suited to most of the common crops of the area as are the finer-textured soils of the Mohave series. Alfalfa and cotton can probably be grown where the gravel content is not too great. Citrus fruits give some promise, as much of the soil is situated on high, sloping ground, comparatively free from frost.

The native vegetation is largely creosote bush, with a small amount of bur sage, paloverde, ironwood, and several varieties of cacti.

Mohave sandy loam, stony phase.—The stony phase of Mohave sandy loam occurs in areas near those of Mohave sandy loam, gravelly phase, generally on moderately or rather steeply sloping alluvial fans not far from the base of the hills. Much of the land is rather uneven and considerably cut by channels of the dry desert washes. Its total extent is 10.3 square miles.

This soil is similar to the gravelly phase of Mohave sandy loam, but contains a larger amount of coarse gravel and stone. The limy subsoil is in many places only a mass of gravelly sand and stone more or less cemented by lime. It is hard to distinguish between soil of this phase and Pinal stony sandy loam which adjoins it in many places.

Areas of this soil join with areas of Mohave stony loam of the Salt River Valley area. In the Paradise-Verde area it occupies the more elevated alluvial-fan slopes, composed of coarser-textured materials, which grade into finer-textured stony loam in the vicinity of the boundary between the two areas.

This soil probably will have only very limited agricultural value because of the coarseness of the soil material and the rather uneven surface. It may prove well suited to citrus fruits, as most of it is favorably situated in regard to freedom from frost. Some land of this kind is being planted to citrus fruits on the Salt River Valley irrigation project, but only a few groves are in the bearing stage. Heavy fertilization will probably be more essential on this soil than on the deeper, fine-textured soils. The water requirement of this soil would doubtless be high and frequent irrigation necessary.

MOHAVE FINE GRAVELLY SANDY LOAM

Mohave fine gravelly sandy loam, together with its deep phase, covers 14.8 square miles of the Paradise-Verde area. It occurs on alluvial-fan slopes, the material of which has been washed out from granitic hills. Drainage is good or excessive.

The surface soil is mellow or loose sandy loam containing a high proportion of coarse angular granitic sand and fine gravel. The subsoil is very similar to that of Mohave loam and Mohave sandy loam, but the soil material is considerably coarser.

This soil is not cultivated in the Paradise-Verde area, but in the Salt River Valley area it is satisfactorily producing alfalfa, cotton, grapefruit, oranges, grapes, and dates. Most of the areas occur on rather high-lying land with good slope and are therefore comparatively frost free and well suited to the production of semitropical fruits and other tender crops.

The native vegetation consists mainly of creosote bush and bur sage, with a few paloverde, and giant and cholla cacti.

Mohave fine gravelly sandy loam, deep phase.—The deep phase of Mohave fine gravelly sandy loam occurs in Paradise Valley along the north edge of the area surveyed. It forms an almost unbroken body for about 6 miles along the abandoned Old Verde Canal, and many narrow tongues extend several miles southward. The land is gently sloping with low ridges rising but little higher than the intervening flats. Drainage is good or excessive.

Soil of this phase is very similar in surface appearance to typical Mohave fine gravelly sandy loam. However, in most places the loose surface layer is rather deep. The material to a depth of 2 feet is in most places rather loose and porous and not distinctly calcareous. Beneath this layer and extending to a depth ranging from 3 to 5 or more feet is somewhat compact light-red distinctly calcareous fine gravelly loam or coarse sandy loam. The compact heavy cloddy red subsoil layer characteristic of the series lies below this layer, averaging about 1 foot thick and underlain, in turn, by the compact gray mottled limy subsoil.

Only a few acres of this soil were under cultivation in 1927-28, producing barley for pasture and hay under dry-farming conditions. Soil of the deep phase probably has much the same adaptations as the typical soil. It gives some promise as citrus-fruit land. The water requirement may prove to be rather high, though the soil occurs in a belt which apparently receives more rainfall than does most of the land in the area surveyed.

MOHAVE FINE SANDY LOAM

Mohave fine sandy loam occurs mainly in Paradise Valley. The largest body is along the road to Scottsdale east and northeast of Camelsback Mountain. The remainder of the soil occurs in long narrow strips or stringers farther north and on the west edge of Paradise Valley northeast of Cactus. The land occupies alluvial fans of gentle or moderate slope and a smooth or slightly ridgy surface.

The surface soil of Mohave fine sandy loam is friable light-brown or light reddish-brown fine sandy loam, in most places only slightly calcareous. Below a depth of 6 or 8 inches the soil material is slightly more compact, grayer, highly calcareous, and slightly mottled or veined with lime. The subsoil between depths of 20 and 30 inches is compact cloddy reddish-brown and grayish-brown mottled material high in lime, similar to the subsoil material in other Mohave soils, but the overlying friable layers are somewhat thicker. The agricultural value of this soil is probably somewhat similar to that of Mohave loam and Mohave sandy loam. It will probably be suitable for most of the common crops of the region, and the more frost-free areas may be used for growing citrus fruits and other comparatively tender crops.

Areas of this soil grade into adjoining areas of Mohave sandy loam in the Salt River Valley area.

ANTHONY SANDY LOAM

Anthony sandy loam occurs on moderately or gently sloping alluvial fans in various parts of the area surveyed. It is most extensive in the eastern end of Paradise Valley, east of the road to Scottsdale, where it forms the greater part of the slightly higher gently undulating land through which extend the narrow flatter areas of Mohave loam. It is also mapped on the southwest edge of Paradise Valley, on the fan slopes of Horseshoe Mountain and Phoenix Mountains, and in the northwest corner of the area west of Luden Mountain. Small bodies lie east of Black Canyon Highway near the north edge of the area, on the south slope of Phoenix Mountains near Sunny Slope, and in Moon Valley. The soil is well or excessively drained. It is developed from alluvial fan deposits of comparatively recent origin.

Anthony sandy loam, as occurring in this area, consists typically of comparatively friable light-brown or dull-brown stratified sandy and gravelly material from 3 to 6 or more feet thick overlying a compact and limy substratum. The texture of the surface soil ranges from fine sandy loam to coarse sandy loam. A small amount of gravel is present over much of the soil, generally being concentrated in small spots or hummocks. Gravelly strata also occur irregularly in the subsoil. The proportion of gravel generally increases in the higher parts of the fans near the hills where the soil adjoins the more gravelly or stony soil areas. The subsoil in most places is slightly compacted but also contains looser, more porous strata. It is more highly calcareous than the surface soil

and has a faint gray netting or veining of lime accumulation. At a depth ranging from 3 to 6 or more feet is a reddish-brown heavier and more compact layer several inches thick, similar to that in the Mohave subsoils but occurring at a greater depth, and below this is a grayer lime layer. This compact heavy-textured material together with the underlying material of high lime accumulation is not typical of the Anthony soils and probably represents an older buried soil over which the Anthony materials of later accumulation have been superimposed.

This soil gives promise of becoming important agriculturally. It will probably prove well suited to alfalfa, cotton, and citrus fruits, as small areas of similar soils in the Salt River Valley area are devoted largely to those crops. Small grains and truck crops may be grown, but probably will not do so well as on the finer-textured soils. This land may require rather frequent irrigation, especially in spots where the subsoil is very loose and gravelly.

The native vegetation consists largely of creosote bush. Some paloverde and ironwood grow along washes. Clearing and leveling will not be difficult in most places.

Anthony sandy loam, stony phase.—The stony phase of Anthony sandy loam occurs almost entirely on the moderately or steeply sloping alluvial fans of McDowell Mountains near the east end of the area. Very small bodies are on the fan slopes around Phoenix Mountains. The surface of the land is generally rather uneven, ridgy, and gullied.

This soil consists of a comparatively loose porous mass of reddish-brown or pale reddish-brown stony or gravelly sandy loam or sand. The topmost few inches are generally not calcareous, but the subsoil is distinctly so, and below a depth of 30 inches large accumulations of lime occur in some places. In such places the soil material has a pinker or grayer cast. The soil material is generally loose and porous throughout. The stones on the surface are in many places numerous and large, but along the edges of the lower-lying areas where the soil merges with typical Anthony sandy loam, the proportion of stone and gravel becomes less.

Most of this soil will probably be of little agricultural value. The work of leveling the land and clearing it of stone will be very great in most places, and the stony character and porosity of the surface soil and subsoil will make cultivation difficult and render the moisture-holding capacity of the soil low. The soil will doubtless require heavy fertilization as it is very low in organic matter, but its location in a comparatively frost-free belt suggests adaptability to the growing of citrus fruits. Its stone content also renders this a very hot soil in this climate, a condition not conducive to free bearing in citrus fruit trees.³

ANTHONY LOAM

Anthony loam occupies long narrow flats along drainage ways in the southern part of Paradise Valley and on the eastern edge of Deer Valley east of Cave Creek. Drainage is fairly good, but, like

³ It is stated by H. A. Severinghaus, former manager of the Arizona Citrus Growers and a producer of citrus fruits, that excessive heat produces a larger summer drop of those fruits.

Mohave loam, this soil receives drainage from somewhat higher land, and as the surface is comparatively flat moisture soaks into the ground and penetrates to a greater depth than in most of the other soils where the run-off is more rapid.

The surface soil of Anthony loam to an average depth of about 10 inches is friable light-reddish brown or light-red loam containing little or no free calcium carbonate. The subsoil is somewhat compact and cloddy reddish-brown or dull-red heavy loam or silty clay loam which is not calcareous in its upper part but below a depth of about 30 inches is faintly veined and netted with gray lime carbonate. The subsoil below a depth of about 40 inches is mellow or slightly compact light reddish-brown fine sandy loam or loam, distinctly calcareous but without any marked concentration of lime. As mapped, this soil probably includes small undifferentiated areas of fine sandy loam, clay loam, and silty clay loam.

As occurring in this area, the soil materials are of somewhat more pronounced red color, and the soil profile is somewhat more maturely developed than in the other members of the Anthony series.

Land of this kind may need some protective drainage when the area is brought under irrigation, but it is considered well suited to the growing of alfalfa, small grain, Bermuda grass for pasture, grain sorghums, and probably lettuce which makes its best growth on medium or heavy textured soils.

The native vegetation consists of mesquite and creosote bush. In places a considerable amount of work will be necessary to clear the land.

Anthony loam, light-textured phase.—The light-textured phase of Anthony loam is inextensive and unimportant. It occurs on flats along the drainage ways in the eastern and northwestern parts of Paradise Valley.

This soil is light pinkish-brown fine sandy loam, sandy loam, or fine sand, very similar to typical Anthony loam but having a lighter-textured surface soil and in some places a looser subsoil. It is somewhat similar to Cajon fine sandy loam and probably has much the same value and crop adaptations as that soil.

Anthony loam, heavy-textured phase.—The heavy-textured phase of Anthony loam occurs in one small body in the southeast part of the area on a flat along the drainage channel which carries the drainage for most of the Paradise Valley. A small tract of this soil joins with Cajon silty clay loam of the Salt River Valley area. In that area it was recognized as being not typical of the Cajon soils and as conforming better in profile to the Anthony soils, but owing to its small extent it was included with the Cajon soils.

This soil is very similar to typical Anthony loam, but the surface soil and subsoil are of somewhat heavier texture. The surface soil varies from heavy loam to silty clay loam.

The native vegetation consists of a rather thick growth of mesquite, and considerable work would be necessary to clear the land. The agricultural value is about the same as for Anthony loam.

ANTHONY FINE SANDY LOAM

Anthony fine sandy loam is rather widely distributed over the Paradise-Verde area, but it is not extensive, most of it occurring in small strips across the center of Paradise Valley and on small fans

at the base of Phoenix Mountains, Lookout Mountain, and Hedgpeth Hills. A very small area joins with similar soils of the Salt River Valley area, which, owing to their small extent, were included with the closely related Cajon soils in the earlier survey. Most of the areas have a moderate or gentle slope and a smooth or slightly ridgy surface.

The surface soil is light reddish-brown or light grayish-brown, tinged with pale-red, friable fine sandy loam or medium sandy loam, in some places not calcareous, but in many places slightly or distinctly so. It contains considerable coarse grit, predominantly granitic. The subsoil is similar to the surface soil in appearance but is slightly more compact and faintly veined and netted with lime-carbonate accumulations. In many places it contains strata of looser sandy or gravelly material. In places a compact reddish-brown subsoil or substratum is reached within a depth of 6 feet or, rarely, within 3 feet of the surface, especially where the soil adjoins bodies of the Mohave soils.

Similar soils in the Salt River Valley are devoted largely to the production of oranges, grapefruit, grapes, alfalfa, and cotton, to which they seem well suited. Sweetpotatoes, potatoes, and other truck crops may also prove fairly satisfactory. Pecans may do well where the friable soil material is deep.

PINAL FINE SANDY LOAM

The surface soil of Pinal fine sandy loam consists of light-brown or light pinkish-brown calcareous friable fine sandy loam to a depth of about 1 foot. In many places hard gray lime-carbonate nodules or caliche fragments are scattered over the surface. The subsoil is light pinkish-gray limy material, somewhat heavier than the surface soil and having a compact nodular or somewhat platy structure. At a depth ranging from 18 to 30 inches, or rarely more, is light-gray lime hardpan or caliche composed of platelike layers. In a few spots the surface soil is very thin, and here and there hardpan crops out on the surface.

This soil occurs in a number of bodies in the west end of Paradise Valley and in Little Deer Valley occupying gently sloping alluvial fans with a fairly smooth surface. Its total area is 3.9 square miles.

Land of this kind will probably prove fairly well suited to the production of most of the common crops of the region, though probably not so desirable as some of the deeper soils on account of its shallowness over the hardpan layer which is apt to restrict root penetration. Some areas are comparatively frost free.

PINAL STONY SANDY LOAM

Pinal stony sandy loam is widely distributed over the area surveyed, having, with its gravelly phase, a total extent of 21.3 square miles. It occurs on alluvial fans close to the base of the hills and mountains. The areas are moderately or steeply sloping and are much cut by dry washes.

The surface of Pinal stony sandy loam is generally covered by a heavy surface concentration or "desert pavement" of angular stone and gravel having a highly polished dark-brown or black stain known as "desert varnish." The surface soil, generally only a few

inches thick, is light grayish-brown, pinkish-brown, or pale-red distinctly or highly calcareous sandy loam. It is underlain by very highly calcareous light pinkish-gray compact material containing much gravel and fragments of hard caliche, resting on a lime-cemented hardpan or caliche which is usually very hard, resembling a conglomerate. The hardpan occurs at depths ranging from a few inches to 2 or more feet. It crops out in a few places and is exposed in the beds and banks of the desert washes.

This soil ranks low in agricultural value. On account of its coarse texture, thin soil mantle, and uneven surface, it seems very doubtful that much of the land can be successfully brought under cultivation. Much of it lies too high to be irrigated under the proposed Paradise-Verde project. As with other gravelly and stony soils in the area, this soil is considered by some to be well suited to the production of citrus fruits because it occurs on high, sloping ground comparatively free from frost, but on account of the drawbacks mentioned it does not seem wise to recommend the soil for citrus culture.

The growth of small forage plants is scant on this soil, and it has little value as grazing land. The natural vegetation includes creosote bush, with various cacti, including the giant, cholla, and barrel varieties. Paloverde and ironwood trees occur in places.

Pinal stony sandy loam, gravelly phase.—Soil of this phase is similar to typical Pinal stony sandy loam, but it is deeper and contains comparatively little stone. The surface soil is light pinkish-gray or pinkish-brown gravelly sandy loam, and the subsoil is light-gray or pinkish-gray compact gravelly sandy loam or loam. A lime-cemented hardpan generally occurs at a depth ranging from 1 to 3 feet.

This soil is very inextensive, occurring in a number of small bodies on the alluvial fans near Cactus, and in Little Deer Valley between Luden Mountain and the Deem Hills. Being deeper and not so coarse, it probably has somewhat greater agricultural value than Pinal stony sandy loam, but it is less desirable than the deeper and finer-textured soils of the area.

CAJON FINE SANDY LOAM

Cajon fine sandy loam occupies long narrow strips paralleling Cave Creek, Skunk Creek, and New River, and forms parts of the flood plains of these intermittent streams. Drainage is good, and there are no alkali concentrations of any consequence. The total extent of the soil is 7 square miles.

Cajon fine sandy loam is friable micaceous light grayish-brown or light pinkish-brown fine sandy loam. The subsoil is very similar to the surface soil but in some locations is slightly pinker. In places it is somewhat stratified, but rarely has any noticeable compaction. Included in mapped areas of this soil are some areas of very fine sandy loam and some of sandy loam texture.

This soil is similar to the Cajon and Gila soils, mapped in the Salt River Valley area, which are producing good alfalfa, cotton, small grains, cantaloupes, lettuce, and other truck crops. It is well suited to sweetpotatoes, potatoes, grapes, and other crops which need a rather light-textured yet fertile soil.

The brush growth is scant on most of this soil, creosote bush being the main species.

CAJON SILT LOAM

Cajon silt loam is closely associated with Cajon fine sandy loam on the flood plain of Cave Creek, where it forms long narrow strips. Small bodies lie near the confluence of Skunk Creek and New River. The land is rather flat but is well drained. The total extent of this soil is 3.8 square miles.

The surface soil of Cajon silt loam is light grayish-brown or pinkish-brown friable or slightly compact silt loam. Small areas of very fine sandy loam and silty clay loam texture are included in mapping. The subsoil is composed of similar, more or less stratified materials, is friable or very slightly compact, and ranges from silt loam to fine sand in texture. In narrow strips of this soil adjoining the Mohave soils, the compact limy subsoil typical of those soils occurs within 6 feet or, rarely, within 3 feet of the surface.

This is an extensive soil in the adjoining Salt River Valley area, where it is considered especially well suited to the growing of lettuce, cantaloupes, and other truck crops. It is also extensively used for the production of alfalfa, cotton, wheat, and barley. Pecans have also been planted on this and similar deep friable soils which are considered especially well suited to this crop.

Cajon silt loam is sometimes called hard land in the Salt River Valley area on account of its tendency to "slick over" when water is applied and to bake on drying. The common method of irrigation on this soil should be modified to allow a greater length of time for the water to sink into the soil. Furrow culture is preferable to flooding in the growing of those crops which allow this practice.

CAJON SANDY LOAM

Cajon sandy loam occurs on the flood plains along New River, Skunk Creek, and Cave Creek. The surface ranges from smooth to somewhat ridgy. Drainage is good or excessive, and alkali salts are not present.

The surface soil is light grayish-brown or light pinkish-brown mellow sandy loam, and the subsoil is friable and very similar to the surface soil but, in places, is stratified with somewhat variable materials. A deep substratum of loose sand or gravel underlies much of the soil.

Much of the land has been cleared, but little is cultivated at present. A small acreage near the mouth of Skunk Creek is watered by pumping from wells and is producing cotton and alfalfa. The soil is well suited to these crops, and may also prove suitable for dates, grapes, and similar fruits. It requires frequent applications of water, and care is needed to prevent excessive loss of water by downward percolation.

Cajon sandy loam, light-textured phase.—Soil of this phase is very similar to typical Cajon sandy loam, with which it is closely associated, but it is lighter textured than that soil. The surface soil consists of sand or loamy sand, in many places containing a considerable amount of gravel. The subsoil is rather loose, porous, and leachy, and the water-holding capacity is low.

Only a few acres of this soil are under cultivation, and the land is devoted to cotton. Much of it could be farmed, but it is not

especially desirable on account of its high water requirement, and some bodies are rather inaccessible as they are surrounded by river wash.

LAVEEN FINE SANDY LOAM

Laveen fine sandy loam occupies a total area of 5.3 square miles, occurring in Deer Valley and Little Deer Valley near Hedgpeth Hills, Deem Hills, and Adobe Mountain, and also in the southeast corner of Paradise Valley. It occupies gently sloping alluvial fans having smooth or slightly ridgy surfaces.

The surface soil of Laveen fine sandy loam is light grayish-brown or light pinkish-gray highly calcareous fine sandy loam. The subsoil, which lies at an average depth of about 1 foot, consists of light-gray or light brownish-gray highly calcareous compact and nodular material, somewhat heavier in texture than the surface soil. This layer extends to a depth of 6 feet in some places, though below a depth of 30 or 40 inches the material is generally somewhat less compact and not so gray in color. In places the surface soil has a sandy loam texture and contains a considerable amount of coarse grit. A fairly large body lying west of Hedgpeth Hills near New River and a small body farther south have this coarser texture and would have been mapped as sandy loam if their total extent had been greater. An area of this soil joins with a small area of Laveen loam of the adjoining Salt River Valley area in which the fine sandy loam member of this series was not differentiated, owing to its small extent.

The agricultural value of this soil is probably the same as that of Mohave sandy loam and Mohave fine sandy loam. Some areas are comparatively frost free and suitable for the growing of citrus fruits.

LAVEEN GRAVELLY SANDY LOAM

Laveen gravelly sandy loam occupies long narrow alluvial-fan ridges in Deer Valley and Little Deer Valley, closely associated with Laveen fine sandy loam. Its total area is 5.2 square miles.

The surface of Laveen gravelly sandy loam is covered with a rather large amount of gravel which in many places forms a "desert pavement" of dark polished pebbles and small stones. The surface soil, which is generally only a few inches thick, is light pinkish-gray or light pinkish-brown gravelly sandy loam. The subsoil is highly calcareous compact and somewhat nodular gravelly sandy loam and is underlain, for the most part within 6 feet of the surface, by a loose gravelly substratum.

Most of this soil will probably be brought under cultivation with the coming of irrigation. It can not be considered as desirable as most of the soils of the area, as its coarse, gravelly texture will make cultivation more difficult, and the ridgy relief does not lend itself so well to irrigation. Its value will probably be much the same as that of the gravelly phase of Mohave sandy loam.

RIVER WASH

Cave Creek, Skunk Creek, and New River at times carry considerable amounts of water during rainy spells, but most of the time they are dry. The stream beds consist largely of loose porous sands,

gravel, and boulders, and the contiguous areas which are occasionally overflowed are also composed of similar loose leachy material. Such areas have no agricultural value and have been mapped as river wash.

ROUGH STONY LAND

The hills and mountains of the Paradise-Verde area consist largely of bare rock with a shallow covering here and there of coarse, loose rock debris. These areas, together with some of the steeper, rougher, and stonier slopes lying at their bases, are mapped as rough stony land. This class of land has no agricultural value and little or no value for grazing.

RECOMMENDATIONS FOR THE AGRICULTURAL DEVELOPMENT OF THE SOILS

The Paradise-Verde area is an area of desert country, almost entirely uncultivated at the present time. For many years, however, hopes and plans for irrigation of the land have occupied the minds of many people.

In 1886 the first attempt to form an irrigation project to water this country was made, when the Rio Verde Canal Co. was organized. Surveys were made, and in the middle nineties the company constructed a number of miles of canal and a tunnel to carry the waters of Verde River to the land. The time was not ripe, however; the company failed to receive the necessary backing, and the project was abandoned. At that time the land was still in public domain. In 1909 the first land was filed on under the homestead act and for a few years settlement proceeded slowly. From 1912 to 1914, the land was taken up rapidly, and settlement continued until 1920, when the State made selections of land, taking practically all the desirable land remaining open to entry. The present irrigation district, called the Verde River Irrigation and Power District, was formed under the State law in March, 1918.⁴ The boundaries of the present district are practically the same as those of the old project. The homesteaders lived on their land long enough to prove up, after which the majority of them left. They did considerable clearing, but much of the land has again grown up to brush. A few people still live on isolated ranches, awaiting the coming of irrigation water.

Of the 209 square miles in the area only a few hundred acres are under cultivation at present. Most of this land is irrigated by pumping from wells and is producing cotton and alfalfa. A few small plots of dry-farmed grain have been grown for pasture and hay.

As the area is almost totally undeveloped, a discussion of agriculture must be limited largely to comparison with conditions in the adjacent Salt River Valley area, a highly developed agricultural section, and predictions of future development here are based on these comparisons.

Similar climatic conditions prevail in the two areas, and most of the soils are similar or practically identical. Therefore it seems safe

⁴ The writer is indebted to William H. Bartlett, secretary of the Verde River irrigation and power district, for much of the information concerning the project.

to say that, in general, the same crops may be grown here and approximately the same average yields obtained as on like soils in the Salt River Valley. Of course this takes for granted the provision of an adequate supply of irrigation water which is not available at present.

In the Salt River Valley in the season of 1926-27,⁵ alfalfa and cotton, the major crops, were nearly equal in acreage. Winter pasture, principally of small grains, occupied a greater acreage, but this was only of a temporary nature. Permanent pasture, wheat, barley, lettuce, cantaloupes, and grain sorghums (maize, hegari, and feterita) are also important crops. A number of fruit crops are of considerable importance owing to the high acre value of the crop produced, but the acreage devoted to them is comparatively small. Chief among the fruit crops are the citrus fruits (oranges and grapefruit), followed by the deciduous fruits (largely apricots, peaches, and pears), and dates, berries, and grapes. Other minor crops are asparagus, alfalfa seed, Bermuda-grass seed, beans, corn for silage, flowers, onions, potatoes, sweetpotatoes, peas, pecans, and watermelons.

The adaptation of the various soils to different crops has been briefly treated in connection with the discussion of the various soil types. One general difference between the soils here and those in the Salt River Valley is that here the soils are lighter and sandier in texture. Sandy loams and loams predominate and clay or adobe soils are absent. This will doubtless have some bearing on crop adaptations. The lighter soils here appear to be well suited to alfalfa, cotton, some of the truck crops, and to dates, grapes, grapefruit, oranges, and other subtropical fruits. The medium or heavier textured soils, which are in the minority, will be better suited to small grains, grain sorghums, pasture grasses, and lettuce than the lighter-textured soils and will probably also be fairly good for alfalfa and cotton.

The possibility of the future cultivation of citrus fruits (grapefruit and oranges) in the Paradise-Verde area is the source of considerable interest and speculation among people who have an interest in the lands. The successful cultivation of these fruits depends on certain climatic conditions, the most important of which is comparative freedom from frost. These fruits will stand temperatures below freezing for short periods, but a great deal of frost always has a detrimental effect. Localities which lie high on the slopes near the base of the hills and mountains have good air drainage, and are comparatively frost free and, consequently, are suited to the growing of these fruits. However, from the viewpoint of favorable depth and texture of the soils and evenness of the surface, many such localities are inferior to lower-lying lands. It is doubtful whether some of the soils, namely, Pinal stony sandy loam and the stony phases of Anthony sandy loam and Mohave sandy loam, can be profitably used for citrus production.

At the present time the pasturing of cattle and sheep in this area during the winter and early spring is of considerable importance. The winter and spring rains favor a growth of small annual herbs

⁵ SALT RIVER VALLEY WATER USERS' ASSOCIATION. CROP REPORT OF SALT RIVER PROJECT, 1926-27.

and grasses, chief among which are Indian wheat (*Plantago* sp.), filaree or alfilaria, and a 6-weeks' grass. These grasses afford good grazing for several weeks, and a large number of cattle and sheep are grazed during that time. At other times they are grazed at high altitudes or pastured and fed on the irrigated lands of the Salt River Valley. The livestock is marketed partly in the Salt River Valley and partly in Pacific coast or middle-western markets.

In this area the raw desert land without water is valued at prices ranging from \$25 to \$150 an acre, depending on location, degree of freedom from frost, and, to some extent, on the character of the soil.

In view of the fact that there is probability of future agricultural development in this area, it will be well to briefly outline a few of the agricultural practices to be recommended. As stated elsewhere, the soils of this region are comparatively rich in the mineral elements, potash, phosphorus, and lime, but very poor in organic matter, humus, and nitrogen. Consequently, it is important to so arrange the system of farming as to provide for the incorporation of organic matter in the soil. The easiest way to supply this is by growing alfalfa in rotation with other crops. It can also be supplied by growing leguminous cover crops, such as cowpeas, tepary beans, and sour clover, and by the application of barnyard manure and commercial fertilizers such as blood meal, tankage, and fish meal. Experiments with phosphate fertilizers, conducted by the Arizona Agricultural Experiment Station, also show that applications of these produce a beneficial effect on some of the crops grown in this area.

IRRIGATION, DRAINAGE, AND ALKALI

Irrigation is necessary for successful production of practically all crops in this area, although occasionally in the winter and spring small fields of grain have been grown without irrigation for pasture and hay.

A few hundred acres lying within the area are being irrigated at present by water pumped from wells. It is the object of the Verde River Irrigation and Power District to irrigate most of the land included in the area, commonly called the Paradise-Verde project. This project comprises a gross area of about 99,000 acres and an estimated net irrigable acreage of about 85,000. It is proposed to develop hydro-electric energy in conjunction with the development of irrigation. Consideration should also be given to the soils in making a land classification and deciding which lands are suitable for irrigation. It is planned to construct storage and diversion dams on Verde River to provide water. In addition, it is the intention to utilize the flood waters of Cave Creek, Skunk Creek, and New River. A flood-control dam on Cave Creek has already been constructed, and the construction of a reservoir on New River is contemplated. It is planned to irrigate about 10,000 acres along the south edge of the project by pumping.

A study of irrigation conditions and the duty of water made in the Salt River Valley by the Division of Agricultural Engineering of the Bureau of Public Roads, United States Department of Agriculture, cooperating with the Arizona Agricultural Experiment Sta-

tion⁶ gives a general idea of what may be expected in the Paradise-Verde area when under irrigation. The important points brought out in this study are:

The average gross duty of water for the Salt River Valley is approximately 5.25 acre-feet per annum and the net duty for all crops, as charged, is about 3 acre-feet. The difference consists of seepage and evaporation losses, water wasted in the operation of canals, and overdelivery.

Alfalfa yields increase with the application of water up to a depth of 7 feet per season, but a depth of 4 feet is considered to be the safe quantity to use from the standpoint of protection from water logging.

The results of observations on a limited number of cotton fields indicated that the yield increased with an increase in the water applied up to a total of $2\frac{1}{4}$ to $2\frac{1}{2}$ acre-feet per annum.

The quantity of water which should be used to irrigate small grain in this section varies from 1.4 to 1.8 acre-feet per acre per season.

Grain sorghum should receive from 0.75 to 1.3 acre-feet of water per acre per season.

Water losses from irrigated fields can be greatly reduced through more careful preparation of land and closer attention in the application of water to land.

Border strips or furrows on the average soil of this valley should not be longer than one-fourth mile and under some conditions should be much shorter than this.

The head of water used, the length and width of land watered at one time, and the slope of the land in the direction of irrigation should be such as to result in even and rapid application of water to the soil.

Since this bulletin was written, a number of canals have been lined with concrete, thus reducing the loss of water and increasing the gross duty of water. Some progress has also been made toward more economical use of irrigation water.

The majority of the soils of the Paradise-Verde area are fairly retentive of water. Anthony sandy loam with its stony phase, the deep phase of Mohave fine gravelly sandy loam, and Cajon sandy loam with its light-textured phase are comparatively loose and porous and absorb water very rapidly. Their water-holding capacity is not so great as that of soils having heavier or more compact subsoils. More frequent but lighter applications of water will be necessary, and greater care must be exercised to prevent loss of water by downward percolation. The shallow soils of the Pinal series can not hold a large amount of water, and frequent light irrigations will doubtless be essential.

The Paradise-Verde area is at present well drained, and the soils are free from harmful accumulations of alkali salts. It is possible that some of the lower-lying areas may need some artificial drainage after the land has been brought under irrigation. Such drainage has been accomplished on the Salt River Valley project by the use of drainage wells, together with a few open-drain ditches. The water from the drainage pumps is used for irrigation, thus augmenting the supply of irrigation water.

SOILS AND THEIR INTERPRETATION

The Paradise-Verde area lies in the geographic-climatic region known as the arid southwest. The soils have developed under a hot, dry climate. Oxidation is generally far advanced, and comparatively

⁶ MARR, J. C., and SMITH, G. E. P. THE USE AND DUTY OF WATER IN THE SALT RIVER VALLEY. Ariz. Agr. Expt. Sta. Bul. 120, 97 p., illus. 1927.

little leaching has taken place. The content of organic matter in the soils is very low and has very little effect on soil color. The vegetative covering is sparse and apparently has had little or no effect on soil formation. The mature soils generally have a distinct reddish or pinkish tinge and the subsurface layers are in many places very red, though this color is sometimes tinged with gray, owing to the accumulation of lime. The surface soils vary from noncalcareous to distinctly or highly calcareous, and lime carbonate is highly concentrated in the subsoils of the older soils. A certain amount of clay and colloid accumulation occurs in the subsoils of the majority of the mature soils and is most marked in places where the land is comparatively flat. In such places moisture penetrates to a greater depth than it does on the higher, more sloping lands. On account of the manner in which the parent soil material has been laid down as alluvial wash by shifting drainage ways, the age of the soils varies greatly, and a mixed, streaked condition in degree of soil development is rather typical of the area as a whole. In comparatively smooth areas sheet wash occurs, and the soil materials are spread thinly and rather evenly over the surface. In such places slow aggradation or building up of the surface soil is taking place. This probably accounts for the presence of a dull-colored surface layer over the redder subsurface layer in many of the mature soils of the area.

The typical maturely developed soil profile of the area is well exemplified by Mohave sandy loam. This soil, as typically developed, has a surface layer consisting of a few inches of light-brown or dull reddish-brown sandy loam, either not calcareous or slightly so. Below this and continuing to a depth of about 1 foot is friable dull-red or reddish-brown sandy loam which is slightly or distinctly calcareous. The upper subsoil layer is dull-red or reddish-brown compact and cloddy material (probably gritty loam or clay loam) somewhat heavier in texture than the surface soil. It is usually somewhat seamed and netted with light-gray accumulations of lime carbonate. Below a depth ranging from 20 to 30 inches is a mottled light-gray or pinkish-gray compact cloddy and somewhat nodular layer of very high lime concentration. In most places this material continues with little change to a depth of 6 or more feet, but in some places a somewhat more friable, less limy layer occurs below a depth of about 40 inches. The depth to the limy layer probably depends on whether the soil material has been accumulated gradually or was laid down in a comparatively short time and has not since been aggraded to a great extent.

The other Mohave soils in general are similar to Mohave sandy loam in profile development. Mohave loam differs from the sandy loam, probably owing largely to its topographic position. It occupies comparatively flat areas which receive some drainage from the slightly higher lands surrounding, and on account of the level surface, moisture penetrates to a greater depth than is common in other Mohave soils. As a result, lime has been leached out to a greater depth, and the accumulation of clay and colloids in the upper part of the subsoil is more pronounced.

The Laveen soils are somewhat similar to those of the Mohave series but have grayer, more highly calcareous surface soils and lack

the compact red upper subsoil layer which characterizes the Mohave soils. Lime-carbonate nodules occur in considerable amounts in many places in the surface soils. The subsoils are gray, compact, limy, and nodular. Apparently in the process of formation of these soils, the surface soil has been disturbed and probably the original surface soil was removed by erosion. In some places the remaining material may have been covered by a more recent surface deposit of limy material.

The Pinal soils have an extreme development of lime accumulation in the subsoil. The lime hardpan in soils of this series is generally very hard, resembling a conglomerate, or concrete. In many places it fractures across embedded pebbles. The surface soil, where undisturbed in the process of soil formation, is light pinkish brown or pale red, similar to that of the Mohave soils. In some places where the soil is comparatively deep there is a suggestion of the compact reddish upper subsoil layer, but in shallower spots the red color is masked by the high concentration of lime.

The Anthony soils are young as regards profile development. They occupy gently sloping alluvial fans and flats along the drainage ways where the soil material has probably not lain exposed to the elements so long as have the Mohave and other mature soils. The surface soil to an average depth of about 8 or 10 inches is light-brown, dull-brown, or pinkish-brown friable material, in some places not calcareous, in others distinctly so. The subsoil is generally slightly pinker than the surface soil, is highly calcareous, and faintly veined or netted with calcium carbonate. It is slightly compact, soft, and cloddy. Coarser, more porous strata occur in the subsoil in many places. Compact layers such as those occurring in the Mohave subsoils sometimes occur in the lower part of the subsoil, but usually at considerable depth. They probably represent an older soil which has been covered by the more recent overwash of the Anthony soils.

The Cajon soils are of very recent origin as compared with other soils of the area. They represent the recent-alluvial deposits of Cave Creek, Skunk Creek, and New River. The materials are deep, friable, and irregularly stratified, and the color is typically light grayish brown with a faint reddish tinge. The subsoils are very similar in appearance to the surface soils and rarely are noticeably compact. Both surface soils and subsoils are generally distinctly and rather uniformly calcareous.

In the mapping of soils as it was first carried on in this part of southern Arizona, a great deal of attention was given to the character of the parent materials. Further study has shown, however, that so far as the profile development of the soils is concerned, the character of the rock material from which they are derived has had comparatively little bearing. The main difference in the soils traceable to differences in parent material is in the texture. Soils which have been derived from the coarse-grained granite, which is a common rock in this section of the country, have a coarse, gritty texture. In the Mohave fine gravelly sandy loam, this coarse angular grit or fine gravel makes up a large proportion of the soil material. The quartzites, schists, and basalts generally give rise to somewhat finer-textured soils, though in some localities they contain larger proportions of the coarser gravels and stone. Wash

from calcareous subsoils and hardpans eroded from higher-lying lands has had an effect on the color and the degree of calcareousness of the surface soils on some of the alluvial fans.

SUMMARY

The Paradise-Verde area is located in Maricopa County, in the south-central part of Arizona, its southern boundary being about 6 miles north of Phoenix. It includes an area of 209 square miles. The area is well drained and free from harmful alkali accumulations. The climate is hot and dry, with a large proportion of sunshiny days. The growing season is long, but irrigation is essential to successful crop production. There are no railroads within the area, but two serve the Salt River Valley area near by. The area has no towns of consequence and is sparsely settled.

In this area 5 series of soils were mapped, including 14 soil types and 11 phases; 2 classes of miscellaneous materials are also shown on the map. The more mature soils are those of the Mohave, Laveen, and Pinal series. The recent-alluvial soils are represented by members of the Anthony and Cajon series. Mohave loam, Mohave sandy loam, Mohave fine gravelly sandy loam with its deep phase, Anthony sandy loam, Cajon fine sandy loam, and Cajon silt loam are among the more extensive soils which give promise of becoming agriculturally important. A number of other less extensive soils will probably also be desirable for agriculture. Pinal stony sandy loam, the stony phase of Anthony sandy loam, and the gravelly and stony phases of Mohave sandy loam will have restricted agricultural value, with possibilities of special adaptation to the production of citrus fruits.

There is practically no agricultural development in the Paradise-Verde area at the present time. Future development is dependent on a sufficient supply of irrigation water. The Verde River Irrigation and Power District has plans for providing such a supply, with the Verde River as the principal source. The land is largely in the hands of homesteaders or small owners who are waiting for the coming of irrigation water.

Soil and climatic conditions are similar to those in the Salt River Valley area where agriculture is highly developed, and a study of the soils and crops in that valley has given a fair idea of what may be expected in the future development of this area. Common crops which will probably be well suited to the area are alfalfa, cotton (long and short staple), wheat, barley, and grain sorghums (milo, hegari, feterita, and others). On some of the finer-textured soils lettuce, cantaloupes, and other truck crops will doubtless thrive; and some of the higher-lying, more frost-free lands will be well suited to the production of citrus fruits (grapefruit and oranges). Dates, grapes, apricots, figs, and other subtropical fruits also give promise.

Raw desert lands may be bought for prices ranging from \$25 to \$150 an acre, depending on location, soil, and probable suitability to citrus culture.

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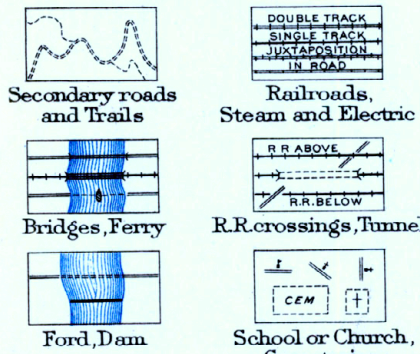
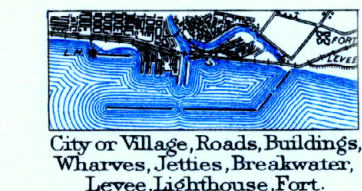
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LEGEND

Anthony sandy loam Ay	Mohave sandy loam Ms
Stony phase	Gravelly phase
Anthony fine sandy loam Af	Stony phase
Anthony loam Am	Mohave fine gravelly sandy loam Mf
Light-textured phase	Deep phase
Heavy-textured phase	Mohave fine sandy loam Mi
Cajon sandy loam Ca	Mohave loam Mm
Light-textured phase	Heavy phase
Cajon fine sandy loam Cf	Stony phase
Cajon silt loam Cs	Gravelly phase
Laveen gravelly sandy loam Ly	Final stony sandy loam Ps
Laveen fine sandy loam Lf	Gravelly phase
River wash Rv	Final fine sandy loam Pf

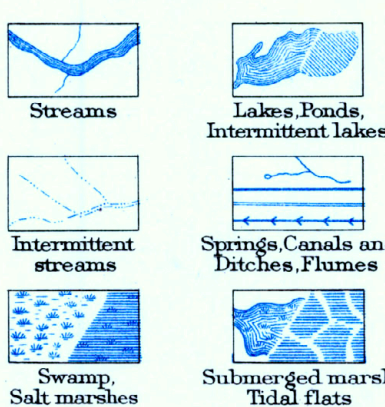
Rough stony land
Rs

CULTURE
(Printed in black)

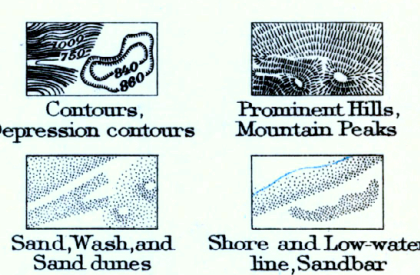


CONVENTIONAL SIGNS

DRAINAGE
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RELIEF
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The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

DIAGRAM
Showing location of Area
in Maricopa County

